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**Contract Number** N00039-01-C-3146 **Copies** 2 **Job Number** 1628

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**Reporting Period** November 2001 **ALPHATECH Reference No.** ____

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**Data Item Number/Sequence Number** A003

**Requirement Title** Electronic Summary Report

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# A Knowledge-Based Indications and Warning Toolkit for Mixed-Initiative Information Warfare Analysis

Shipboard intelligence centers deployed in littoral regions are the "front line" for naval intelligence gathering. Onboard cryptanalysts need to monitor multiple information sources for trends and deviations from expected norms, detect and properly interpret the unusual, and generate Indications and Warning (I&W). Anticipated reductions in shipboard manning and increases in the quantity of available sensor data will further exacerbate workload for intelligence personnel. New information fusion technology is required to help intelligence analysts meet these challenges.

During Phase I, we constructed an ontology of the I&W generation domain, developed pattern scripting tools to capture patterns of potential interest, and designed a data-driven inference engine to identify enemy activities from large volumes of sensor data.

The objective of the *ontology* is to represent key features of the sensor domain and the Information Warfare (IW) battlespace. An ontology is a vocabulary that represents the key features of a domain and translates the important domain-level terms into a formal language . It includes machine interpretable definitions of basic concepts in the domain and relations between them. In our application, the ontology provides us the basic "building blocks" or data model from which more complex patterns and scripts can be constructed. The ontology developed for the I&W domain models the sensor domain, elements of the IW battlespace, and operational activities and intentions. The I&W ontology centers around two basic components: (1) Sensor Data, and (2) Battlespace Data.

In order to assess potential situations of interest, intelligence analysts rely upon knowledge and experience gained in the analysis of past events and situations. Over time, analysts may assess a number of similar situations occurring within their domain, and patterns may emerge that characterize situations or events of interest. To aid the analyst in accurately assessing situations and events, pattern scripting tools are required to define and create models describing each type of situation of potential interest. During Phase I we developed two pattern scripting tools, the *Rules Wizard* and the *Script Editor,* to allow the analyst to relate events and objects in certain ways that can describe the general pattern of occurrences within situations of interest. These tools enable a user who is neither a computer programmer nor a logician to write rules in a language we developed, the *pattern query language*, that is close to ordinary English, but it also has a formally specified syntax that makes it possible to translate such rules into a formal representation. The two major components of the pattern query language are **trends** and **scripts**.

Finally, during Phase I we developed a pattern identification process consisting of three steps. During the first step, the *Data Transformer* module performs basic statistical operations on the raw sensor data. The purpose of this step is to transform the sensor data into the sensor domain ontology. During the second step, the *Pattern Compilation Tool* translates the trend and script representations into a mathematical formulation that

can be systematically solved. During the last step, the *Inference Engine* matches the transformed sensor data against the enemy patterns defined by the user and computes a confidence level for each trend and script. This confidence level is a quantitative measure of whether the observed events are indicative of the behavior captured by the particular trend or script.

The resulting Phase I I&W generation toolkit

- Provides a "corporate memory" that captures analysts' local I&W expertise.
- Facilitates timely analysis of large quantities of sensor data gathered from multiple sensors.
- Enables detection of Indications and Warnings quickly and reliably in the face of new and complex signal environments, with a much smaller staff.